Control and coordination

5

"The nervous system, in coordination with the endocrine system communicates, integrates and coordinates the various organs and organ systems in the body."

5.1 Introduction

All living organisms including plants and animals respond and react to environmental factor or stimuli. There is necessity to develop some system for control and coordination of various body organs.

To carry out a simple function such as picking up an object from the ground there has to be coordination of the eyes, hands, legs and the vertebral column. The eyes have to focus on the object, the hands have to pick it up and grasp it, the legs have to bend and so does the back bone (vertebral column). All these actions have to be coordinated in such a manner that they follow a particular sequence and the action is completed. A similar mechanism is also needed for internal functions of the body.

The individuals also have to adjust to the changing conditions around them and vary their responses. At the same time, the internal conditions of the body should be maintained constant.

There are two modes of control and coordination, chemical and nervous. Plant do not have a nervous system. They possess only chemical control and coordination. Animals have both chemical and nervous control and coordination. The two constitute neuroendocrine system.

Stimulus : An agent or a change in the external or internal environment that induces reaction in the body.
Response : A change in activity in the body of an organism due to stimulus.

5.2 Coordination in animals

Animals have the ability of locomotion. This ability probably developed as they have to search for food. Since they move from one place to another, the animals have to continuously encounter changes in their environment. In order to maintain a steady state within the body, all animals should be able to perceive these changes and adapt to them.

With increasing complexity in their structure, the number and types of cell in the animal body increased. Thus it became necessary to have some coordination mechanism. Two systems have been developed for better control and coordination of the various activities of the organisms. These systems are the Nervous System and the Endocrine System.

Animals receive a variety of external information through specialised structures called sense organs (receptors). These are photoreceptors for light, phonoreceptors for sound, olfactory receptors for smell, gustatory receptors for taste and thigmo or tango receptors for touch.

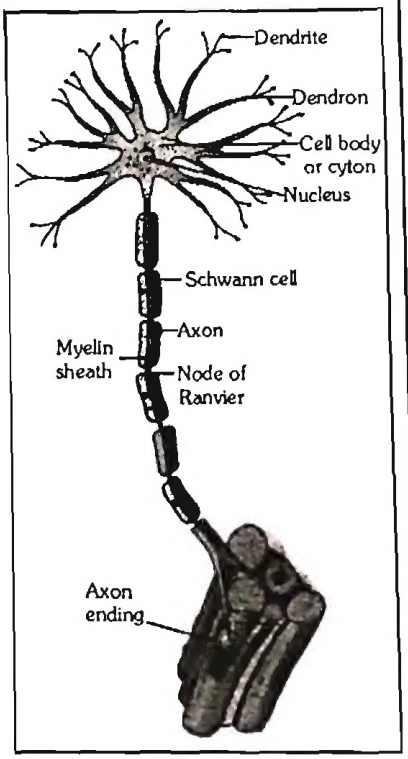


Fig.1 Structure of Neuron

5.3 Nervous system

The nervous system in vertebrates is highly evolved. It is the control system for all our actions, thinking and behaviour.

It is concerned with receiving stimuli from the external or internal environment of the body, interpreting these stimuli and producing the appropriate response to these stimuli. To achieve this, highly specialized cells are required which can receive the message and conduct them to the chief centres of nervous system where they are to be interpreted and then returned to the relevant part of the body. Neurons or nerve cells are the structural and functional unit of nervous system. Each neuron has following two parts:

(i) **Cyton or cell body** – Contains a central nucleus and cytoplasm with characteristic deeply stained particles called Nissl's granules [i.e. clumps of ribosomes].

(ii) **Cell processes** – These are of two types

(a) **Dendrites :** These may be one to many, generally short and branched cytoplasmic processes. Dendrites are afferent processes because they receive impulse from receptor or other neuron and bring it to cyton.

(b) **Axon :** It is single generally long efferent process which conducts impulse away from cyton to other neuron.

Longest cell in the body is neuron because axon can be more than one metre long. Axon has uniform thickness but it has terminal thin branches called telodendria. Terminal end buttons or synaptic knobs occur at the end of telodendria.

Nerve fibre : An axon of a neuron covered by one or two sheaths is called nerve fibre. The nerve fibre may be very small (microscopic) or can be upto one metre in length.

Nerves : Bundle of nerve fibres covered by a tubular sheath (nerve sheath) constitutes nerves. The nerve arises from brain and spinal cord and branched out to almost all parts of the body.

Three types of nerves

(1) **Sensory nerve :** Contains only sensory nerve fibres bringing impulses from receptors to CNS. Example - Optic (eye) nerve and auditory (ear) nerve arising from eye and ear respectively and ending in brain.

(2) **Motor nerve :** Contains only motor nerve fibres carrying impulses from CNS to effectors. Examples - nerve arising from brain and connected to muscles of eyeball in order to rotate the eye.

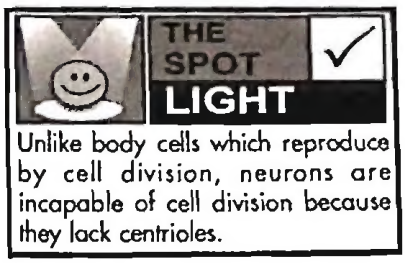
(3) **Mixed nerve :** Contains both sensory and motor nerve fibres.

Example - Spinal nerves.

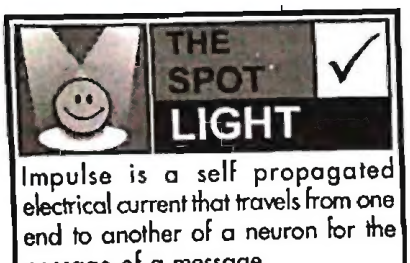
Electrochemical mechanism of transfer of nerve impulse

Any two neurons in the nervous system do not join to one another completely, there is always a very small gap between the two neurons. This gap is called synapse. The nerve impulse is carried over this small gap between a pair of neurons by means of a chemical substance called neurotransmitter substance.

When a stimulus acts on the receptor a chemical reaction is set off which produces an electrical impulse in it. This impulse travels from the dendrite of sensory neurons to its cell body and then along its axon.



Unlike body cells which reproduce by cell division, neurons are incapable of cell division because they lack centrioles.



Impulse is a self propagated electrical current that travels from one end to another of a neuron for the passage of a message.

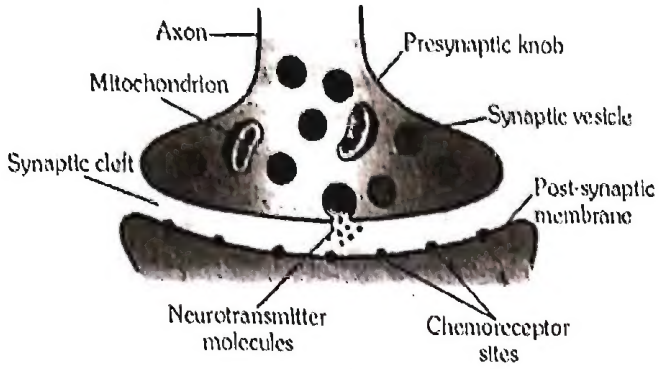
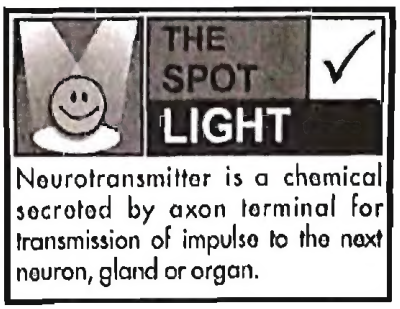


Fig.2 Synapse

At the end of axon of sensory neuron, the electrical impulse releases tiny amount of a chemical substance in the synapse. This chemical substance crosses the gap and starts similar electrical impulse on the dendrite of next neuron. This process continues till the electrical impulse reach the relay neurons in brain and spinal cord. These relay neurons connect in a similar way from the brain and spinal cord to the effector muscles and glands via motor neuron.



Neurotransmitter is a chemical secreted by axon terminal for transmission of impulse to the next neuron, gland or organ.

BUILDING CONCEPTS 5.1

Why synapse acts as a one way valve?

Explanation

Synapses act like one way valves. This is because the chemical substance is present at only one side of the gap i.e. neurotransmitters are released by axon endings only and received by dendrites of other neuron. In this way synapses ensure that nerve impulse travels only in one direction.

Neuromuscular Junction

A neuromuscular junction is a place in the body where the axons of motor nerves meet the muscle, thus transmitting message from the brain or spinal cord which causes the muscle to contract and relax.

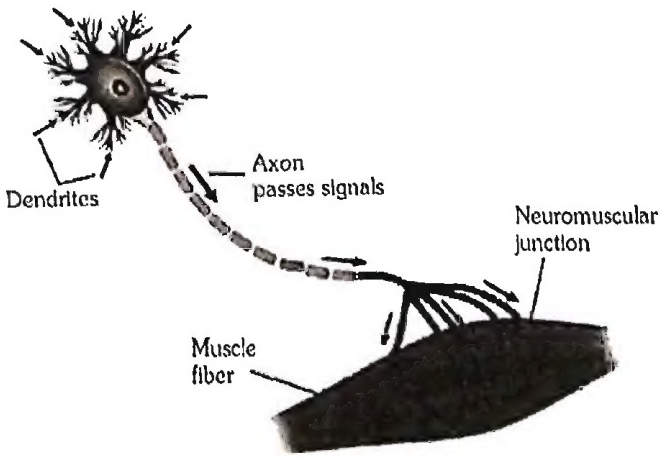
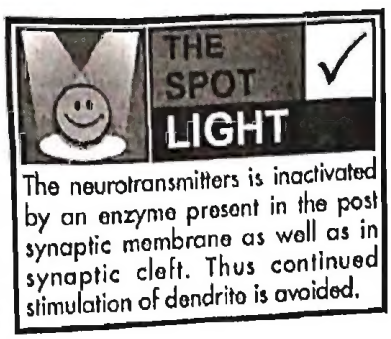


Fig.3 Neuromuscular junction



The neurotransmitters is inactivated by an enzyme present in the post synaptic membrane as well as in synaptic cleft. Thus continued stimulation of dendrite is avoided.

BUILDING CONCEPTS 5.2

How does a muscle cell move?

Explanation

Muscle cells move by changing their shape so that they shorten. Muscle cells have special proteins that change both their shape and their arrangement in the cell in response to nervous electrical impulses. When this happens, new arrangements of these proteins give the muscle cells a shorter form.

THE SPOT LIGHT

Reflex action are of two types :
(1) Unconditioned reflex – which are inborn and inherited. E.g. sneezing and coughing
(2) Conditioned reflex – which are learned reflexes. E.g. cycling and salivation on smelling one's favourite food.

Fig.5 Watering of mouth-Conditioned reflex action.

Reflex Action

A reflex action is a quick involuntary action in response to an external or internal stimulus, generally without involvement of the brain.

E.g. A tap on the knee result in a spontaneous withdrawl i.e. a knee-jerk. Similarly, when we touch a hot object we spontaneously withdraw our hand.

Significance of Reflex Action

Act as an alarm which indicate about some unnatural incidents that are going to happen.

Quick and sudden reflex protect us from dangers and injuries.

Reflex Arc

A reflex arc is the shortest route that can be taken by an impulse from receptor to an effector.

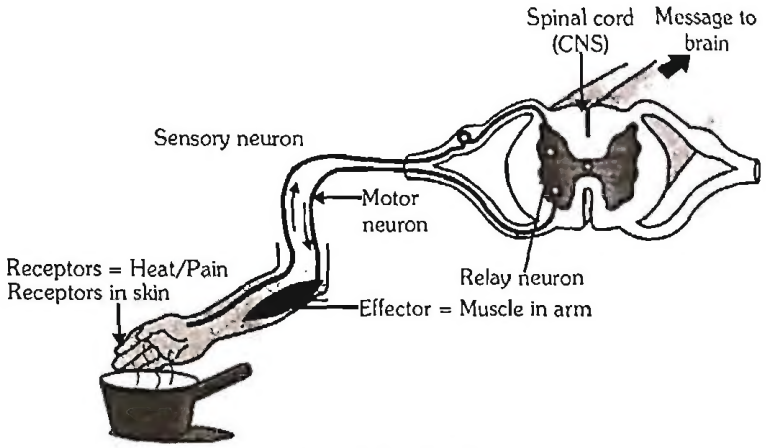


Fig. 4 Reflex arc

The basic components of reflex arc are a receptor, a sensory neuron a centre, a motor neuron and an effector. Components of reflex arc are -

(1) Receptor : The dendrite of sensory neuron receives stimulus and initiate a nerve impulse.

(2) Sensory neuron : The nerve impulse passes from the dendrites to the axon terminal branches of the sensory neuron in the spinal cord.

(3) Centre : It is the region in the spinal cord or brain where the incoming sensory impulse generates an outgoing motor impulse. Relay neuron are found in brain and spinal cord and allow sensory and motor neurons to communicate.

(4) Motor neuron : It transmit the impulse generated by the sensory neuron in the centre to the effector organ of the body that will respond, such as a muscle or gland.

(5) Effector : It is the organ of the body that responds to motor nerve impulse.

BUILDING CONCEPTS 5.3

What is the role of the brain in reflex action?

Explanation

The reflexes which involve only the spinal cord are called spinal reflexes. The spinal reflexes are produced in the spinal cord but the message of reflex action taken also goes on to reach the brain where the thinking process occurs. Some reflex arcs involve the brain, rather than the spinal cord only. They are called cerebral reflexes. Closing of eyes when exposed to flash of light and salivation at the sight of tempting food are the examples of cerebral reflexes.

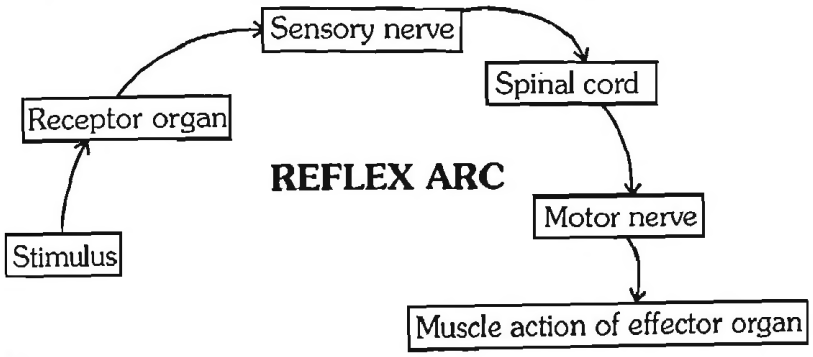
BUILDING CONCEPTS 5.4

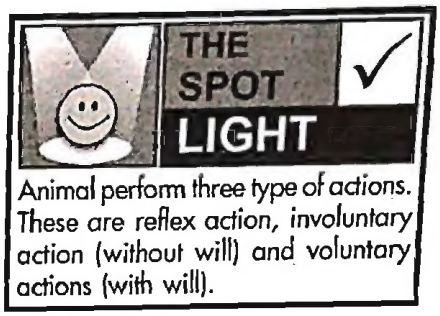
What reflexes are shown by our eyes to the changes in light intensity?

Explanation

As the person enters a dark room from brightly lit one, the pupil dilates to allow more light to enter the eye. On the contrary, when the person is exposed to light on leaving a dark room, the pupil constricts and the eyelids close partially to allow less light to enter into the eye.

A typical reflex action has the following pathway





Animal perform three type of actions. These are reflex action, involuntary action (without will) and voluntary actions (with will).

BUILDING CONCEPTS 5.5

What is the difference between a reflex action and walking?

Explanation

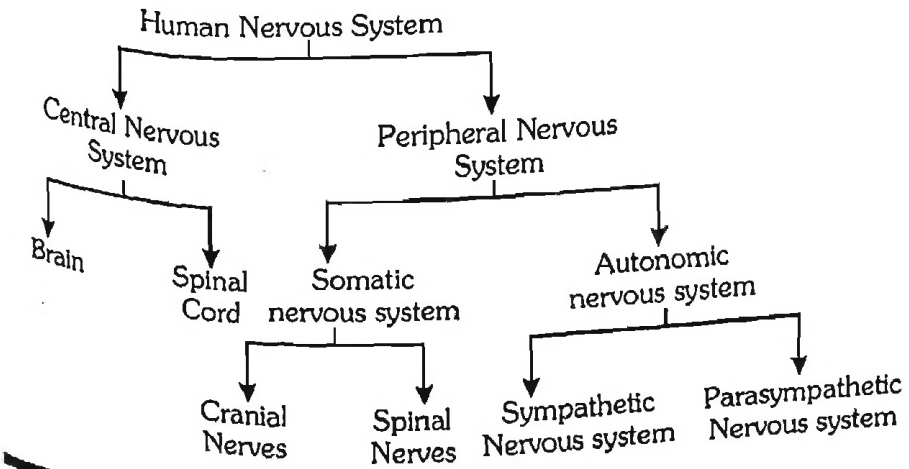
Reflex action	**Walking**
1. Reflex action is the immediate and involuntary action	1. Walking is a voluntary action which is under our control.
2. It is regulated by the spinal cord.	2. It is controlled by brain.
3. It occurs in a fraction of seconds.	3. It takes longer time.

CHECK YOUR CONCEPTS 5.1

1. Name the part of neuron which receives and conducts the impulse respectively.
2. Name the various components of reflex arc.
3. We suddenly withdraw our hand when a pin pricks. Name the type of response involved in this action.

The vertebrate nervous system consists of two parts

(1) Central Nervous System
(2) Peripheral Nervous System



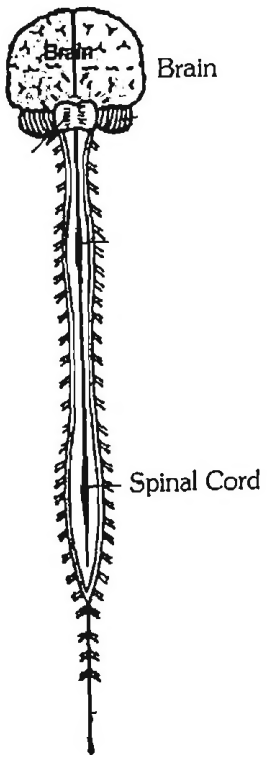


Fig.6 Central nervous system

(1) Central nervous system

The central nervous system consist of two parts (i) upper large brain situated in the head and (ii) the lower long and narrow spinal cord situated in the neck and trunk. It is continuation of brain downwards.

(i) Brain

It is the part of the central nervous system that is present in the head. The bony box that houses the brain within the skull is called the cranium. It has three main regions the fore brain, the mid brain and the hind brain. The three regions have different parts that have specific functions.

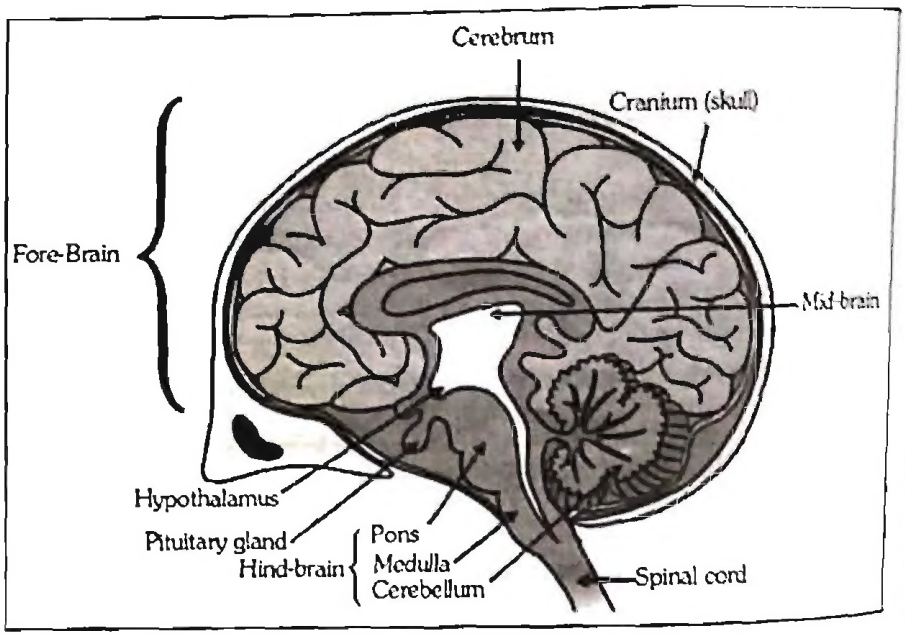


Fig.7 Sagittal (median) section of human brain

Fore brain

It is made up of cerebrum, hypothalamus and many other parts.

(a) Cerebrum

It is the largest and main thinking part of the brain and is made up of two hemispheres called the cerebral hemispheres. The cerebrum has sensory areas, association areas and motor areas. Sensory areas receive the messages. There are different areas for hearing, smell, sight and so on in cerebrum. There are separate areas of association where this sensory information is interpreted by putting it together with information from the other receptors as well as with information that is already stored in brain. The motor areas are responsible of the action of the voluntary muscles. Cerebrum is also responsible for the intelligence, memory, consciousness and will power.

(b) Hypothalamus

Hypothalamus is an important region of the brain. It receives the taste and smell impulses, coordinates message from the autonomous nervous system, controls the heart rate, blood pressure, body temperature and peristalsis. It also forms an axis with the pituitary which is the main link between the nervous and the endocrine systems. It also has centres that control emotions, hunger, thirst, fatigue, sleep, body temperature and sweating. It secretes neurohormones which regulate the secretion of anterior lobe of pituitary.

THE SPOT LIGHT

The brain of an average adult is made up of about 1000 billion neurons and weighs approximately 1300 g.

THE SPOT LIGHT

Olfactory lobes are a part of fore brain. They are related with smell sensation.

Mid brain

It is a small portion of the brain that serves as a relay centre for sensory information from the eyes and ears to the cerebrum. It also controls the reflex movements of the ears and eyes muscles. It provides a passage for the different neurons going in and coming out of the cerebrum.

Hind brain

It consists of cerebellum, pons varoli and medulla oblongata.

(a) Cerebellum

Cerebellum is second largest part of brain. It is responsible for maintaining the balance while walking, swimming, riding, etc. It is also responsible for precision and the fine control of the voluntary movements. For example, we can do actions like eating while talking or listening. The action of eating, while talking is done automatically. This is controlled by the cerebellum. Alcohol effects the cerebellum.

(b) Pons

Pons literally means bridge. It is hidden as it is well protected because of its importance. It has the breathing centre.

(c) Medulla oblongata

Medulla oblongata is the posterior most part of the brain which lie below the cerebellum. It controls activities such as sneezing, coughing, swallowing, salivation and vomiting. It contains centre which control respiration and cardio vascular reflexes. It also controls rate of heart beat and expansion and contraction of blood vessels to regulate blood pressure.

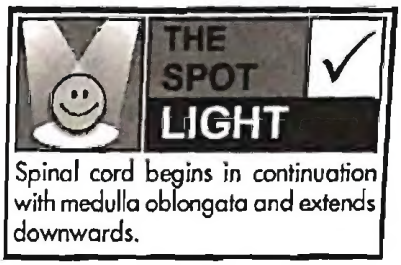
(ii) Spinal cord

It is a collection of nervous tissue running along the back bone. It is protected by the vertebral column.

The functions of the spinal cord are :

Coordinating spinal reflexes.

It conducts sensory and motor impulse to and from the brain via sensory and motor nerve fibres respectively.



Spinal cord begins in continuation with medulla oblongata and extends downwards.

BUILDING CONCEPTS 5.6

How is the nervous tissue protected from any damage?

Explanation

External injuries are overcome by the central nervous system through protective shields. The spinal cord is encased in the vertebral column, and it is also surrounded by a fluid known as cerebrospinal fluid. The same fluid is also present in the cranium around the brain. In addition, the brain and spinal cord are guarded by layers of tissue described as meninges, namely duramater, arachnoid and piamater from outside to inside.

(2) Peripheral nervous system

All the nerves arising from brain and spinal cord are included in peripheral nervous system. It is divided into somatic nervous system and autonomic nervous system.

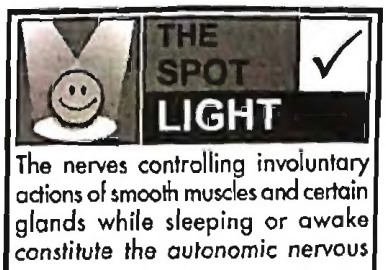
Somatic nervous system consists of two sets of nerves :

(i) **Cranial nerves**

Nerves arising from brain are called cranial nerves. Nerves may be sensory, motor or mixed. 12 pairs of cranial nerves are found in humans.

(ii) **Spinal Nerves**

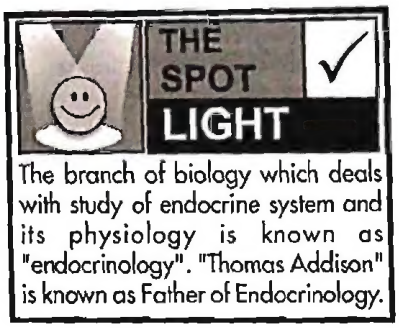
Nerves arising from spinal cord are called spinal nerves. Each spinal nerves is of mixed type. In human 31 pairs of spinal nerves are found.



The nerves controlling involuntary actions of smooth muscles and certain glands while sleeping or awake constitute the autonomic nervous system.

CHECK YOUR ANSWERS 5.1

1. Dendrites and axon respectively.
2. Receptors, sensory neuron, centre, motor neuron and effector.
3. Reflex action.



The branch of biology which deals with study of endocrine system and its physiology is known as "endocrinology". "Thomas Addison" is known as Father of Endocrinology.

5.4 Endocrine system

A group of endocrine glands which produce various hormones form the endocrine system. In addition to nervous system, the endocrine system also helps in coordinating the activities of our body.

Endocrine glands – The duct less glands which pour their secretions directly in the blood are called endocrine glands.

Hormones –They are secretions of the endocrine glands and one of the important substances that controls the body chemistry. Also known as "Chemical messengers."

Physical and chemical properties of hormones

(i) These are secreted by endocrine glands.

(ii) Hormones are secreted only when required.

(iii) Their secretion is regulated by feedback mechanisms.

(iv) These are generally released in the blood stream.

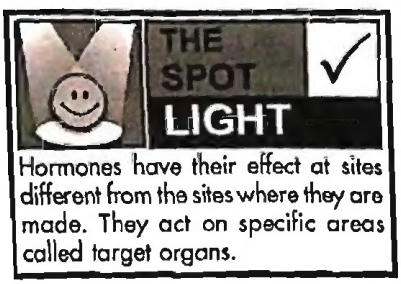
(v) The molecules of most of the hormones are small.

(vi) The secretion of hormone is always in very small quantity.

(vii) Hormones are destroyed after use i.e. hormones can not be stored in the body. Thyroxine is an exception.

CHECK YOUR CONCEPTS 5.2

1. Which part of brain controls posture and balance of the body?
2. How is the spinal cord protected in human body?
3. Name the part of fore brain which forms a link between nervous system and endocrine system?



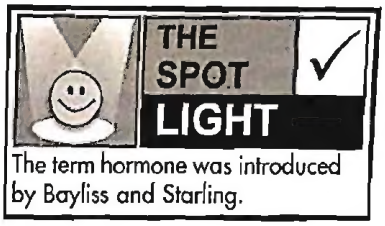
Hormones have their effect at sites different from the sites where they are made. They act on specific areas called target organs.

Transfer of information in multicellular organisms

Electrical impulses are an excellent means for transfer of information rapidly. But there are some limitations to the use of electrical impulses. They will reach only those cells that are connected by nervous tissue. Once an electrical impulse is generated in a cell and transmitted, the cell will take some time to reset its mechanisms before it can generate and transmit a new impulse. So that multicellular organisms use another means of communication between cells namely, chemical communication. This will be slower and it can be done steadily and persistently because it can potentially reach all cells of the body.

In chemical communication, stimulated cells release a chemical compound (hormone) which diffuse all around the original cells. If other cells around have the means to detect this compound using special molecules on their surfaces, then they would be able to recognise information and even transmit it.

Difference between Nervous and Hormonal Coordination	
Nervous Coordination	**Hormonal Coordination**
It is sent as an electrical impulse along axons, and as a chemical across synapse.	It is sent as a chemical messenger via blood stream.
Information travels rapidly, in milliseconds.	Information travels slowly.
Information is directed to specific receptors–one or a few nerve fibres, gland cells or other neurons.	Information is spread throughout the body by blood from which the target cells or organs pick it up.
It gets response immediately.	It get response usually slowly.
Its effects are short-lived.	Its effects are generally more prolonged.



The term hormone was introduced by Bayliss and Starling.

BUILDING CONCEPTS 5.7

How does chemical coordination takes place in animals?

Explanation

In animals, chemical coordination is achieved through the agency of hormones which function as chemical messengers or informational molecules. Hormones are secreted in very small amount by specialised tissues in the body called endocrine glands. These glands are ductless and pour their secretions directly into blood. Blood transports them to the target tissues/organs. Hormones coordinate the activities of living organisms and also their growth. For example, pancreas secretes two hormones-insulin and glucagon.

CHECK YOUR ANSWERS 5.2

1. Cerebellum.
2. Overlying meninges and vertebral column.
3. Hypothalamus

Endocrine glands

The various endocrine glands in humans are hypothalamus, pituitary gland, thyroid gland, parathyroid glands, pancreas, adrenal glands, ovary (in female) and testis (in males).

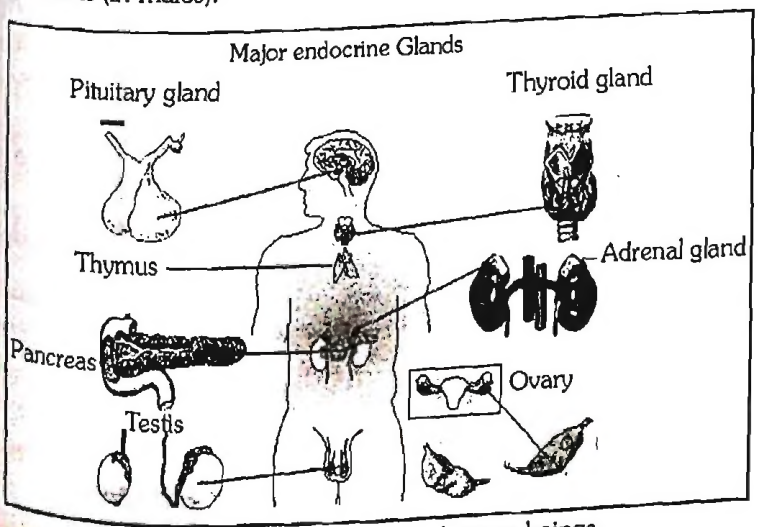
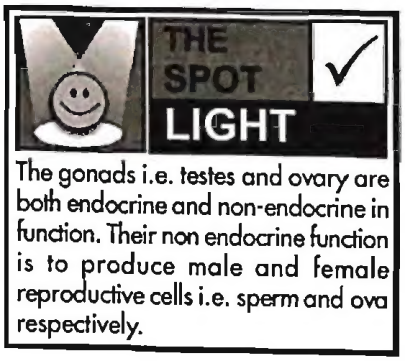


Fig.8 Endocrine glands in human beings.

Pituitary gland is known as 'Master gland' of the body. It is because of the fact that the pituitary gland controls the functioning of most of the endocrine glands.

Endocrine Gland	Hormone	Function	Deficiency may cause
Pituitary	Growth Hormone	Regulates growth and development of body	Dwarfism
	ADH	Regulates the concentration of urine	Diabetes insipidus
Thyroid Gland (Largest endocrine gland)	Thyroxine	Controls carbohydrate, protein and fat metabolism. It regulate BMR [Basal metabolic rate]	Goitre
	Calcitonin	Regulates blood calcium levels	
Adrenal gland	Adrenaline	Prepares the body to deal with emergency situations	–
Pancreas	Insulin	Decrease blood sugar levels	Diabetes mellitus
	Glucagon	Increase blood sugar levels	
Testes	Testosterone	Causes development of sexual organs and secondary sexual characteristics in males	–
Ovary	Oestrogen	Causes development of sexual organs and secondary sexual characteristics in females	–
	Progesterone	Maintains pregnancy	–



The gonads i.e. testes and ovary are both endocrine and non-endocrine in function. Their non endocrine function is to produce male and female reproductive cells i.e. sperm and ova respectively.

BUILDING CONCEPTS 5.8

How does our body respond to emergency situation like fight?

Explanation

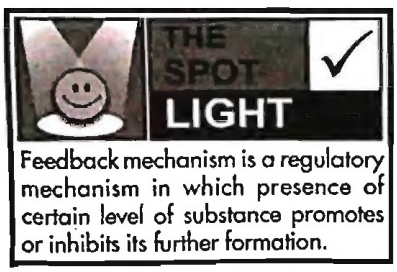
In case of flight reaction to an emergency situation, Adrenal glands release adrenaline into blood.

(i) The heart begins to beat faster resulting in supply of more oxygen to the muscles.

(ii) The blood to the digestive system and skin is reduced due to the contraction of smooth muscles around small arteries in these organs. This diverts the blood to our skeletal muscles.

(iii) The breathing rate increases because of the contraction of the diaphragm and the rib muscles.

(iv) All these responses together enable the body to be ready to deal with the situation.



Feedback mechanism is a regulatory mechanism in which presence of certain level of substance promotes or inhibits its further formation.

CHECK YOUR CONCEPTS 5.3

1. Name the gland which secrete growth hormone.
2. Name the hormone that helps in regulating level of sugar in our blood. Name the gland that secretes it.
3. Why are some patients of diabetes treated by giving injections of insulin?

Feedback mechanism

Hormone regulation is mostly done by feedback mechanism. A good example of negative feedback is the hormone insulin. Insulin is a hormone produce by the pancreas. Insulin is released when the amount of glucose in the blood goes up. It stimulates the target cells to take glucose out of the blood which is utilized in cell respiration or is stored as glycogen. When cells take up glucose from the blood this makes the glucose level normal. With fall in blood glucose level insulin secretion decreases. This checks the further fall in blood glucose level. So the negative feedback work to keep the blood glucose level normal.

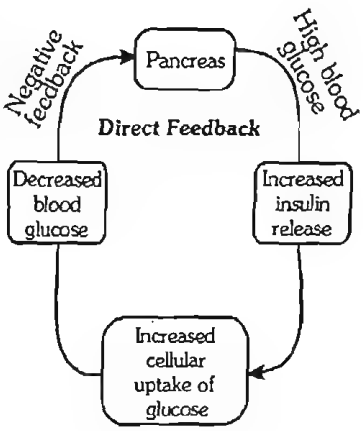


Fig.9 Feedback mechanism

BUILDING CONCEPTS 5.9

Why is the use of iodized salt advisable?

Explanation

Iodine is important for the thyroid gland to make thyroxin hormone. Thyroxine regulates carbohydrates, proteins and fat metabolism in the body so as to provide the best balance for growth. If iodine is deficient in the diet, thyroxine cannot be produced and the thyroid gland at the neck swells, a condition called goitre. Use of iodized table-salt can provide the required amount of iodine in the diet.

5.5 Coordination in plants

Plants have neither a nervous system nor muscles. But they give response to stimuli. The higher plants are fixed to the substratum by means of roots. They can not move from one place to another. They therefore show movement of their parts only.

The plants coordinate their behaviour against environmental changes by using hormones. These hormones affect the growth of a plant. Which may result in movement of shoot and root of plant.

BUILDING CONCEPTS 5.10

Explain why the responses shown by plants are slow in comparison to animals.

Explanation

Plant do not have nervous system like the animals have which is responsible for the quick response to stimuli. Instead they use only hormones for producing reaction to external stimuli, which are responsible for the slow response to stimuli.

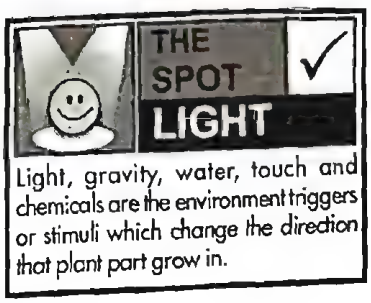
CHECK YOUR ANSWERS 5.3

1.
2. Pituitary gland.
3. Hormone – Insulin, Gland – Pancreas

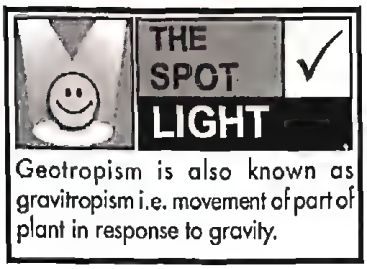
The insulin hormone controls the metabolism of sugar. When pancreas does not produce and secrete sufficient amount of insulin into blood, then the sugar level in the blood rises. Therefore, the patient excretes sugar (glucose) in urine, feels excessive thirst and also uninates excessively. So, people having severe diabetes are treated by giving injections of insulin.

Movement in plants

Plants show two different types of movement. The plants may either respond to various stimuli very slowly by growing e.g. when a seed germinates the root goes down and the stem comes up into the air or they can show rapid movements like leaves of sensitive plant move very quickly in response to touch by folding and drooping without growing.



Light, gravity, water, touch and chemicals are the environment triggers or stimuli which change the direction that plant part grow in.



Geotropism is also known as gravitropism i.e. movement of part of plant in response to gravity.

Classification of plant movements

These are of two types

Plant movement

Dependent on growth / Tropic / Directional movement	Independent on growth / Nastic / Non directional movement

Both tropic and nastic movement can be either due to differential grow or due to change in turgidity.

Movement due to differential growth are irreversible while movement d to change in turgidity are reversible.

Tropic movement

Tropic movement is the directional movement of the part of a plant cause by its growth. The growth of a plant part in response to the stimulus ca be towards the stimulus (positive tropism) or away from the stimul (negative tropism).

Types of tropic movements

(1) Phototropism (2) Geotropism (3) Chemotropism

(4) Hydrotropism (5) Thigmotropism

(1) Phototropism

The movement of a part of the plant in response to light is callec phototropism. If the plant part moves towards light is called positive phototropism and if the plant part moves away from light then it is called negative phototropism.

Active Biology 5.1

Aim : To demonstrate the response of plant to the direction of light.

Method

(i) Take a plant in a conical flask with water.

(ii) Take a cardboard box which is open from one side.

(iii) Keep the flask in the box in such a manner that open side of box faces light coming from the window and then observe it.

(iv) Now turn the flask so that the shoots are away from light and the roots towards light. Leave it undisturbed in this condition for a few days. Again observe carefully to find the difference in the movement.

Observation

(i) In the first case, the shoots bend towards light and the roots bend away from light.

(ii) In the second case when the flask was turned it was found that the shoots grow again by bending towards light and roots grow by bending away from light.

Conclusion

The shoots show positive phototropism while the roots show negative phototropism.

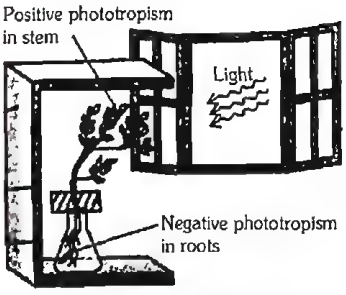


Fig.10 Response of the plant to the direction of light

BUILDING CONCEPTS 5.11

Plant A is kept in light which is coming from right direction and plant B is kept in light which is coming from left direction. What will happen if we inter change the positions of these two plants?

Explanation

Plant B moves towards the right direction and plant A moves towards the left direction after interchanging the position because shoot gives positive response towards the light.

(2) Geotropism

The movement of a part of the plant in response to gravity is called geotropism. Roots of a plant move downwards in the direction of gravity it is called positive geotropism and stem of a plant moves upwards against the direction of gravity it is called negative geotropism.

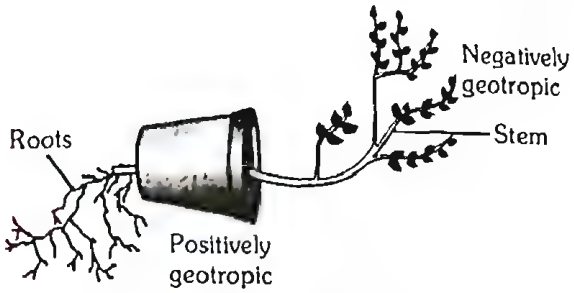


Fig.11 Plant showing geotropism

(3) Chemotropism

The movement of a part of plant in response to a chemical stimulus is called chemotropism. e.g. Growth of pollen tube towards the ovule during the process of fertilization in a flower.

(4) Hydrotropism

The movement of a part of plant in response to water is called hydrotropism. Roots of seedling show positive hydrotropism.

ACTIVE BIOLOGY 5.2

Aim : To demonstrate that roots show hydrotropism.

Method

Place germinating seeds in moist saw dust contained in a sieve.

Observation

(i) The radicles pass down and come out of the sieve pores under the influence of gravity.

(ii) After some growth, radicles move back and enter the saw dust again.

Conclusion

(i) This shows that roots show both hydrotropic response and geotropic response.

(ii) The hydrotropic response of root are stronger than geotropic response.

(5) Thigmotropism

The movement of a part of plant in response to contact or support is called thigmotropism. e.g. Pea plant climb up other plants or fences by mean of tendrils. Tendrils are sensitive to touch. When tendrils come in contact with any support, the part of the tendril in contact with the object does

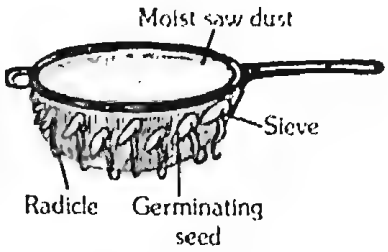


Fig.12 Hydrotropism

THE SPOT LIGHT

Tendril is a thread like structure which can be formed from modified shoots or leaves. It is used by climbing plants for support and attachment generally by twining around whatever it touches.

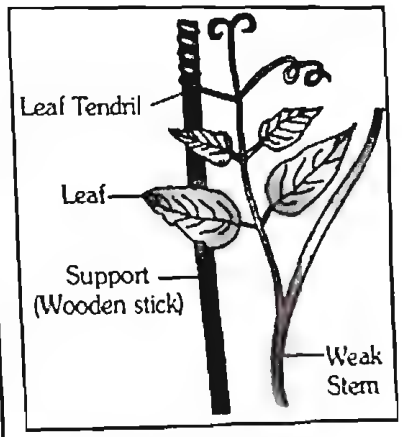


Fig.13 Thigmotropism

not grow as rapidly as the part of tendril away from the object. This causes the tendril to circle around the object and thus cling to it.

Movement	Stimulus	Example
Phototropism	Light	Bending of shoot towards light.
Geotropism	Earth's gravity	Bending of roots towards ground.
Chemotropism	Chemicals	Growth of pollen tube towards ovule.
Hydrotropism	Water	Movement of roots towards ground water.
Thigmotropism	Contact	Movement of tendril towards support.

Nastic movement

Movement which is neither towards nor away from the stimuli is called nastic movement. It is growth independent movement.

Seismonastic / Thigmonastic movements

Such movements occur in response to touch (shock). These movements are very quick and are best seen in 'touch-me-not' plant (*Mimosa pudica*), also called 'Chhui-mui' or 'Lajwanti' or 'sensitive plant'.

If we touch the leaves of the chhui-mui plant with our finger, the stimulus is transmitted to its base and then to other parts through the xylem sap, probably in the form of a chemical. Due to which all its leaves immediately fold up and drop. After sometime, the leaves regain their original status. Here, no growth is involved. Instead, plant cell change shape by changing the amount of water in them (turgor changes), resulting in folding up and drooping of leaves.

Fig.14 Response to touch in *Mimosa pudica*

Difference between tropic and nastic movement

Tropic movements	Nastic movements
Direction of movement is in the direction of the stimulus or against it.	Movement are non directional.
Growth takes place.	Growth does not take place.
Movements are slow.	Movements are fast.
E.g. Growth movement of shoot towards light.	E.g. The folding up and drooping of leaves in the sensitive plants.

Chemical coordination in plants

It takes place by the plant hormones or phytohormones. They help to coordinate growth, development and response to the environment. They are synthesized in minute quantity in one part of the plant body and simply diffuse to another part, where they influence specific physiological processes.

THE SPOT LIGHT

A number of flowers close up when light fades in the evening and re-open the next day when light appears. It is an example of nastic movement. The stimulus is light in this case.

THE SPOT LIGHT

In vascular plants specially in taller ones if apical bud is remove it causes fast growth of lateral buds. The influence of apical bud in suppressing the growth of lateral buds is termed as apical dominance

Types of phytohormones or growth regulators

Growth promoter	Growth inhibitor
1. Auxins	1. Abscisic acid
2. Gibberellins	2. Ethylene
3. Cytokinins	

Growth promoters

(1) Auxins

Auxin was the first plant hormone discovered by Went. It promotes cell elongation, apical dominance and help in root initiation in cutting or in callus differentiation.

THE SPOT LIGHT

The effect of auxin on the growth of root is exactly opposite to that on a stem. In high concentration, auxin inhibits root elongation and instead, enhance adventitious root formation.

Role of auxin in phototropism

When growing plants detect light, a hormone called auxin, synthesized at shoot tip, helps the cells to grow longer.

When light is coming from one side of the plant, auxin diffuses towards the shady side of the shoot.

This concentration of auxin stimulates the cells to grow longer on the side of the shoot which is away from light. Thus, the plant appears to bend towards light.

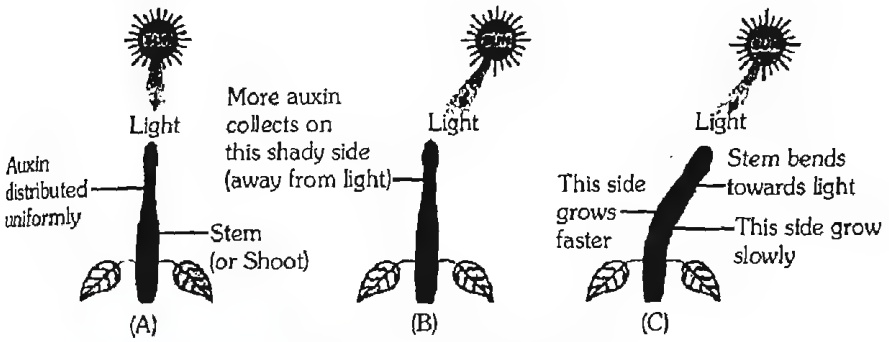


Fig.15 The role of auxin in phototropism

BUILDING CONCEPTS 5.12

A plant is grown in the open ground with the sunlight coming from above, then the stem of plant grows straight up. Why?

Explanation

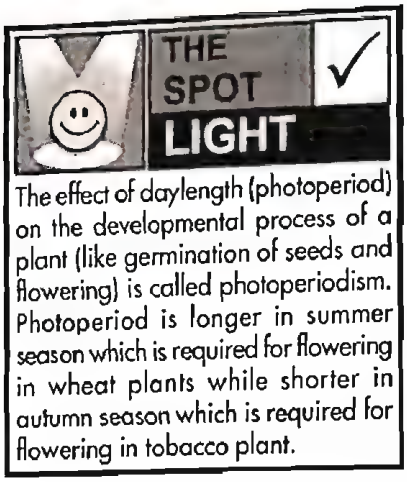
When the sunlight comes from above then the auxin hormone present in the tip of stem spreads uniformly down the stem. Due to the equal presence of auxin both the sides of stem grow equally and thus it grows straight up.

(2) Gibberellins (G.A.)

It is found in various plant parts such as root, stem, leaves, fruits and immature seeds. It stimulate stem elongation or help in growth of the stem. It helps in breaking dormancy in seeds and buds. It promotes growth in fruits and increases size and number of fruits.

THE SPOT LIGHT

Seed dormancy is the mechanism to prevent germination during unsuitable ecological condition.



The effect of daylength (photoperiod) on the developmental process of a plant (like germination of seeds and flowering) is called photoperiodism. Photoperiod is longer in summer season which is required for flowering in wheat plants while shorter in autumn season which is required for flowering in tobacco plant.

CHECK YOUR CONCEPTS 5.4

1. How do auxins promote the growth of a tendril around a support?
2. Name the plant hormone
   (i) Which break dormancy in seeds.
   (ii) Which promotes apical dominance in plants?
3. A potted plant is made to lie horizontally on the ground. Which part of the plant will show
   (i) Positive geotropism (ii) Negative geotropism

(3) Cytokinins (CK)

Cytokinins promote cell division, and they are present in greater concentration in areas of rapid cell division such as in fruits and seeds. It promotes opening of stomata.

Cytokinins suppress apical dominance (promotes lateral branches in the presence of apical bud). Help in secondary growth (growth in thickness). It helps in breaking the dormancy of seeds and buds.

Growth inhibitors

(1) Abscisic acid (ABA)

It is called stress hormone which inhibit the growth. It promotes the closing of stomata under water stress condition thus effects wilting of leaves.

It cause dormancy of seeds and promotes falling of leaves.

(2) Ethylene

It is a gaseous hormone which promotes fruit growth and ripening.

It prevents elongation of stem and roots in longitudinal direction. It promotes yellowing and senescence of leaves.

CHECK YOUR ANSWERS 5.4

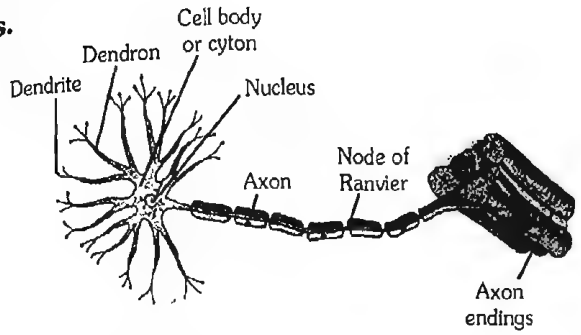
1. The movement of tendril around the support is caused by the hormone auxin. Less auxin occurs on the side of contact as compared to the free side. Auxin promotes the growth on the free side. As a result of growth on the free side, the tendril coils around the support.
2. (i) Gibberellin (ii) Auxin
3. (i) Root system (ii) Shoot system

1. What is the function of receptors in our body? Think of situations where receptors do not work properly. What problem are likely to arise?

Ans. All information from environment is detected by receptors. Receptors pass information in the form of electrical impulses to brain by nerve cells and brain send information to effector organs for response. When receptors do not work properly, information from environment (stimuli) cannot be detected and our body cannot respond accordingly.

2. Draw the structure of a neuron and explain its function.

Ans.



Function of a neuron :

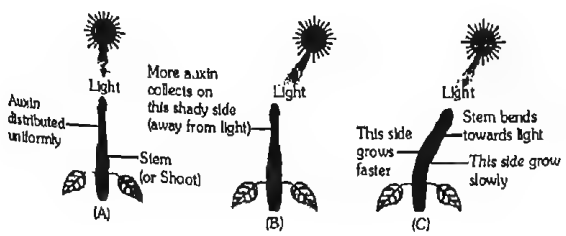
(i) It helps in conducting impulses which enables the organism to show responses towards the stimuli.

(ii) It helps in regulating control and coordination in animals.

3. How does phototropism occur in plants?

Ans. The directional movement of a plant part/plant in response to light is called phototropism. The shoot responds by bending towards light while roots responds by bending away from the light. The plant stem responds to light and bends towards it due to the action of auxin hormone. This happens as follows.

(i) When sunlight falls on the plant, the auxin hormone present at the tip of the stem spreads uniformly down the stem. Due to the equal presence of auxin, both the sides of the stem grow straight and with same rapidity.



(ii) When the light falls only on the right side of the stem, then the auxin hormone collects in the left side of the stem, away from the light. This is because auxin hormone prefers to stay in shade, i.e., moves away from the light. Thus, more auxin hormone is present in the left side of stem as compared to the right. The left side of stem, grows faster than its right side and therefore, the stem bends towards the right side (direction of light).

The effect of auxin on the growth of a root is exactly opposite to that on a stem. Auxin hormone increases the rate of growth in stem but it decreases the rate of growth in a root. The side of root away from light will have all the auxin concentrated in it. Due to this, the side of root which is away from light will grow slower than the other side and make the root bend away from light.

4. Which signals will get disrupted in case of a spinal cord injury?

Ans. Spinal cord is an important component of Central Nervous system. In case of a spinal cord injury, reflex actions and involuntary actions will get disrupted.

5. How does chemical coordination occur in plants?

Ans. In plants, chemical coordination occurs with the help of plant hormones (phytohormones). Different plant hormones help to coordinate growth, development and responses to the environment. They are synthesised at places away from where they act and simply diffuse to the area of action, for example, auxin. Another example of plant hormones are gibberellins which help in growth of the stem. Cytokinins promote cell division. Abscisic acid is a plant hormone which inhibits growth and its effects include wilting of leaves. Ethylene is a gaseous plant hormone which helps in ripening of fruits

6. What is the need for a system of control and coordination in an organism?

Ans. Multicellular organisms have diverse structure and functions. There are different systems which perform specific function but the functioning of one system is not independent from the other. There is integration of all functional activities of the

organisms. For example, digestive enzymes are secreted into the food canal only when there is food. The integration is possible because of communication and control. Communication makes control possible. The control and coordination occurs by two systems, i.e.,

(i) by the release of chemical messengers called the hormones from endocrine system

(ii) by the conduction of nerve impulse, i.e. nervous system.

7. How are involuntary actions and reflex actions different from each other?

Ans.

Involuntary actions	Reflex actions
They involve autonomic nervous system.	They involve nerves, brain and spinal cord.
They usually occur in response to internal stimuli.	They operate against harmful stimuli which are generally external and may cause injury.
They are connected with functioning of internal body parts.	They are connected with emergency.
These are regulated by medulla (hind-brain).	Reflex action is controlled by spinal cord.
The speed of response is slower.	The speed of response is very fast.
Example: Beating of heart muscle.	Example: Removal of hand with jerk when someone touches a hot object accidently.

8. Compare and contrast nervous and hormonal mechanisms for control and coordination in animals.

Ans.

Difference between Nervous and Hormonal Coordination	
Nervous Coordination	**Hormonal Coordination**
It is sent as an electrical impulse along axons, and as a chemical across synapse.	It is sent as a chemical messenger via blood stream.
Information travels rapidly, in milliseconds	Information travels slowly
Information is directed to specific receptors–one or a few nerve fibres, gland cells or other neurons.	Information is spread throughout the body by blood from which the target cells or organs pick it up.
It gets response immediately	It gets response usually slowly
Its effects are short-lived	Its effects are generally more prolonged

9. What is the difference between the manner in which movement takes place in a sensitive plant and the movement in our legs?

Ans.

Movement in Sensitive Plant	Movement in Legs
It occurs in response to an external stimulus like touch and shock.	It occurs in response to our requirement and is determined by will.
Plant cells change shape by changing the amount of water (turgor changes).	Movement in our legs is voluntary action which is controlled by nervous system.
No nerves are involved.	Nerves carry the message for movement of legs.
It is controlled by plant hormones.	It is controlled by cerebrum and cerebellum.

EXERCISE # 1

Multiple choice questions

1. Power of regeneration is lowest in
(1) Nerve cell (2) Liver cell
(3) Bone cell (4) Muscle cell

2. "Nodes of Ranvier" are found in
(1) Muscles (2) Heart (3) Axon (4) Eye

3. The part of brain responsible for controlling and regulating the memory and reasoning is
(1) Cerebellum (2) Cerebrum
(3) Hypothalamus (4) Medulla oblongata

4. Afferent nerve fiber conducts impulse from
(1) C.N.S. to effector (2) Receptor to C.N.S.
(3) Receptor to effector (4) Effector to receptor

5. Cerebellum is concerned with
(1) Co-ordination of muscular movement
(2) Memory
(3) Vision
(4) Reflex action

6. Excitability and conductivity are the outstanding property of
(1) Spleen (2) Artery
(3) Vein (4) Nerve fibre

7. Hyposecretion of ..... in children causes dwarfism.
(1) Thyroxine hormone (2) Growth hormone
(3) Adrenaline hormone (4) Vasopressin hormone

8. Gigantism results due to
(1) Excess secretion of thyroxin
(2) Less secretion of growth hormone
(3) Less secretion of adrenaline
(4) Excess secretion of growth hormone

9. Name the hormone which controls basal metabolic rate in animals.
(1) Adrenaline (2) ADH
(3) Estrogen (4) Thyroxine

10. Which statement is not true about thyroxine?
(1) Iron is essential for the synthesis of thyroxine.
(2) It regulates carbohydrates, proteins and fats metabolism in the body
(3) Thyroid gland requires iodine to synthesise thyroxine
(4) Thyroxine is also called thyroid hormone

11. The fight, flight and fright hormone is
(1) Glucagon (2) Insulin
(3) Progesterone (4) Adrenaline

12. Goitre results from
(1) gibberelline excess
(2) Iodine deficiency
(3) calcium depletion
(4) calcium excess

13. Select the mis-matched pair.
(1) Adrenaline : Pituitary gland
(2) Testoterone : Testes
(3) Estrogen : Ovary
(4) ADH : Pituitary gland

14. Which of the following hormone controls appearance of secondary sexual characters in human male?
(1) Testosterone (2) Progesterone
(3) Thyroxine (4) Estrogen

15. Dramatic changes of body features associated with puberty are mainly because of secretion of
(1) Estrogen from testis and testosterone from ovary
(2) Eestrogen from adrenal gland and testoterone from pituitary gland
(3) Testosterone from testis and estrogen from ovary
(4) Testosterone from thyroid gland and estrogen from pituitary gland

16. *Mimosa pudica* (touch me not plant) shows
(1) Thigmotropism movement
(2) Chemotactic movement
(3) Phototropic movement
(4) Seismonasty

17. The growth of pollen tubes towards ovules is due to
(1) Hydrotropism (2) Chemotropism
(3) Geotropism (4) Phototropism

18. The growth of tendril in pea plants is due to
(1) Effect of light
(2) Effect of gravity
(3) Rapid cell divisions in tendrillar cells that are away from the support
(4) Rapid cell division in tendrillar cells in contact with the support

19. Which of the following effects of auxins is of wide application?
(1) Induction of callus differentiation
(2) Induction of root initiation
(3) Apical dominance
(4) All of the above

20. Apical dominance means
(1) Supression of growth of apical bud by axillary buds
(2) Supression of growth of axillary buds by the presence of apical bud
(3) Stimulation of growth of axillary buds by removal of apical bud
(4) Inhibition of growth of axillary buds by removal apical bud

21. Which of the following breaks the dormancy of seeds?
(1) Auxin (2) GA
(3) Ethylene (4) All the above

22. Stem elongation is affected by
(1) Gibberellin and ABA (2) Auxin and gibberellin
(3) Ethylene and cytokinin (4) Cytokinin and auxin

23. Cytokinin
(1) Is a hormone whose main function is to induce cell division
(2) Is the process of cell division
(3) Retards cell division
(4) Causes dormancy

24. Abscisic acid induces
(1) Shoot elongation
(2) Cell elongation and cell wall formation
(3) Cell division
(4) Leaf fall and dormancy

25. Which of the following is a growth inhibitor hormone?
(1) Cytokinin (2) Gibberellin
(3) Auxin (4) Abscisic acid

True or false

1. Axon endings of a neuron receive the stimuli.
2. Tangoreceptors detect touch.
3. Medulla oblongata controls involuntary functions.
4. All the voluntary actions of the body are coordinated by the cerebrum.
5. Cranial nerves arise from brain and they are 12 in number.
6. Secretion of exocrine glands is known as hormone.
7. Thyroid gland is the largest endocrine gland of the body.
8. Progesterone is also known as pregnancy hormone.
9. Hypothalamus is the main link between nervous system and endocrine system.
10. The movement of a plant part in response to water is called hydrotropism.
11. Auxin initiates the root formation.
12. Abscisic acid is the only gaseous plant hormone.
13. The phenomenon of apical dominance is due to the plant hormone - gibberellins.
14. Ethylene induces ripening of fruits.
15. Cytokinins cause seed dormancy.

Fill in the blanks

1. .... tissue is made up of an organised network of neurons.
2. .... is the part of a neuron where information is acquired.
3. Through the neuron, information travels as an ....
4. .... is the functional and structural unit of nervous system.
5. Main parts of a neuron are .... and
6. All information from our environment is detected by the specialized .... cells.
7. .... receptors detect taste while .... receptors detect smell.
8. Central nervous system consist of .... and ....
9. .... is the main thinking part of the brain.
10. .... coordination is seen in both plants and animals.
11. Largest part of brain is ....
12. Hormones are .... substances secreted in .... quantities by ....
13. .... hormone regulates growth and development of the body.
14. .... is the only hormone which is stored in our body.
15. Element .... is essential for the synthesis of thyroxine.
16. Secretion of ductless gland is called ....
17. Deficiency of insulin hormone causes ....
18. Pancreas is the type of .... gland.
19. The master gland in human body is ....
20. A .... mechanism regulates the action of the hormones.
21. Phototropic movements take place due to the stimulus of ....
22. Organic substances which regulates the growth of plant, are called ....
23. Yellowing of leaves is induced by.................. hormone.
24. When growing plants detect light, a hormone called .... is synthesized at the shoot tip.
25. Plant hormone .... promotes cell division.

Match the column

1.

Column A	Column B
(i) Cerebellum	(a) Neuron
(ii) Spinal cord	(b) Axon endings
(iii) Phonoreceptors	(c) Breathing centre
(iv) Functional and structural unit of nervous system	(d) Close relation between two neuron
(v) Neurotransmitter	(e) Detect sound
(vi) Pons	(f) Dendron
(vii) Synapse	(g) Reflex actions
(viii) Small cell process of neuron	(h) Maintain balance and posture

2.

Column A	Column B
(i) Ovary	(a) Testosterone
(ii) Master gland	(b) Diabetes insipidus
(iii) Emergency hormone	(c) Pituitary
(iv) ADH	(d) Adrenaline
(v) Testis	(e) Estrogen

3.

Column A	Column B
(i) Ethylene	(a) Positive phototropic
(ii) Root	(b) Positive geotropic
(iii) Abscisic acid	(c) Stress hormone
(iv) Stem	(d) Ripening of fruits
(v) *Mimosa pudica*	(e) Thigmonasty
(vi) Auxin	(f) Apical dominance

EXERCISE # 1 ANSWER KEY

Multiple choice questions

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	3	2	2	1	4	2	4	4	1	4	2	1	1	3
Que.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**					
Ans.	4	2	3	4	2	2	2	1	4	4					

True or false

1. False **2.** True **3.** True **4.** True **5.** False **6.** False **7.** True **8.** True **9.** True **10.** True
11. True **12.** False **13.** False **14.** True **15.** False

Fill in the blanks

1. Nervous **2.** Dendrite **3.** electric impulse **4.** Neuron **5.** cyton ; cell processes
6. Receptor **7.** Gustatory ; olfactory **8.** Brain ; Spinal cord
9. Cerebrum **10.** Chemical **11.** Cerebrum **12.** chemical ; small; endocrine gland
13. Growth **14.** *Thyroxine* **15.** *iodine* **16.** hormone **17.** Diabetes mellitus
18. heterocrine/mixed **19.** Pituitary **20.** feedback **21.** Light **22.** *Phytohormones*
23. ethylene **24.** Auxin **25.** Cytokinin

Match the column

1. (i) - h, (ii) - g, (iii) - e, (iv) - a, (v) - b, (vi) - c, (vii) - d, (viii) - f,
2. (i) - e, (ii) - c, (iii) - d, (iv) - b, (v) - a
3. (i) – d, (ii) – b, (iii) – c, (iv) – a, (v) –e, (vi) – f

EXERCISE # 2

Very short answer type questions

1. Name the specialised cell of multicellular animals that perceive external stimuli.
2. Name the two systems that control and coordinate all other systems in human body.
3. What is neuron?
4. What happens when an impulse travel through a neuron?
5. What is the basic function of a receptor?
6. Name the reflex centre of the brain.
7. What is the significance of reflex action?
8. What is the function of cerebrospinal fluid?
9. State one main function of cerebrum.
10. Mention the various components of hind-brain.
11. Which part of the brain contains respiratory centre?
12. Name the largest and second largest part of the brain.
13. Mention the number of cranial nerves.
14. Where is hypothalamus gland located? What does it produce? State the function of hypothalamus.
15. Name the hormone responsible for regulation of :
    (i) metabolism of carbohydrates, fats and proteins.
    (ii) balance of calcium and phosphate
    (iii) blood pressure.
    (iv) water and electrolyte balance.
16. What is thyroid gland and state its location.
17. Name the two hormones secreted by pancreas. Write one function of each hormone named.
18. Name the ovarian hormones and give the function of any one of them.
19. What are tropic movements?
20. What are nastic movements?
21. Which type of movement is shown by the leaves of "touch-me-not" when touched?
22. What are phytohormones?
23. Name the three stimuli which act on plants.
24. Give the major role of cytokinin in plants.
25. Which growth regulator is found in the form of gas?
26. Which growth hormone is present in the tip of a stem?
27. Name the plant hormone which causes stem elongation and leaf elongation.
28. Which hormone is used for artificial ripening of fleshy fruits?
29. Name the stress hormone in plants.
30. Name the growth inhibitor in plants.

Short answer type questions

1. Draw a diagram of a neuron.
2. Give the technical names for the following receptors in the animals :-
    (i) Receptors for light
    (ii) Receptors for temperature
    (iii) Receptors for sound
    (iv) Receptors for smell
3. Define nerve impulse. Which structure in a neuron helps to conduct a nerve impluse.
    (i) towards the cell body
    (ii) away from the cell body
4. Explain how nerve impulse travel in the body.
5. What are voluntary and involuntary actions? Give examples.
6. How is the brain protected against shock?
7. Which parts of human brain are responsible for sensation of smell?
8. Name the regions of the fore-brain and mention any one function per region.
9. State the functions of cerebrum.
10. Give an account of the structure of hind brain.
11. Write the difference between cerebellum and cerebrum.
12. Bring out any two differences between enzymes and hormones.
13. "There is close coordination between nerves and hormones". Explain with an example.
14. State the main function of 'pituitary gland'. Write the effect of :
    (i) excessive and
    (ii) sluggish activity of this gland on the growth of a child.
15. Justify that the pancreas and the gonads perform dual functions.

Long answer type questions

1. What do you mean by feedback mechanism? How hormones are being regulated by this mechanism?
2. What are reflex actions? Define reflex arc. Draw a neat and labelled diagram of the components in a reflex arc.
3. What are the two major components of nervous system in animals and how is one different from the other?
4. Describe the central nervous system in human beings.
5. What is the peripheral nervous system? How does information transfer in multicellular organisms?
6. What is endocrine system? Show in a tabular form the names of endocrine glands, hormones secreted by them and their functions.
7. Differentiate tropic and nastic movements. Write their different types with examples.
8. What is phototropism and geotropism? With labelled diagrams describe an activity to show that light and gravity change the direction that plant parts grow in.
9. Explain the role of growth promoters in plants.
10. Explain the role of growth inhibitors in plants.